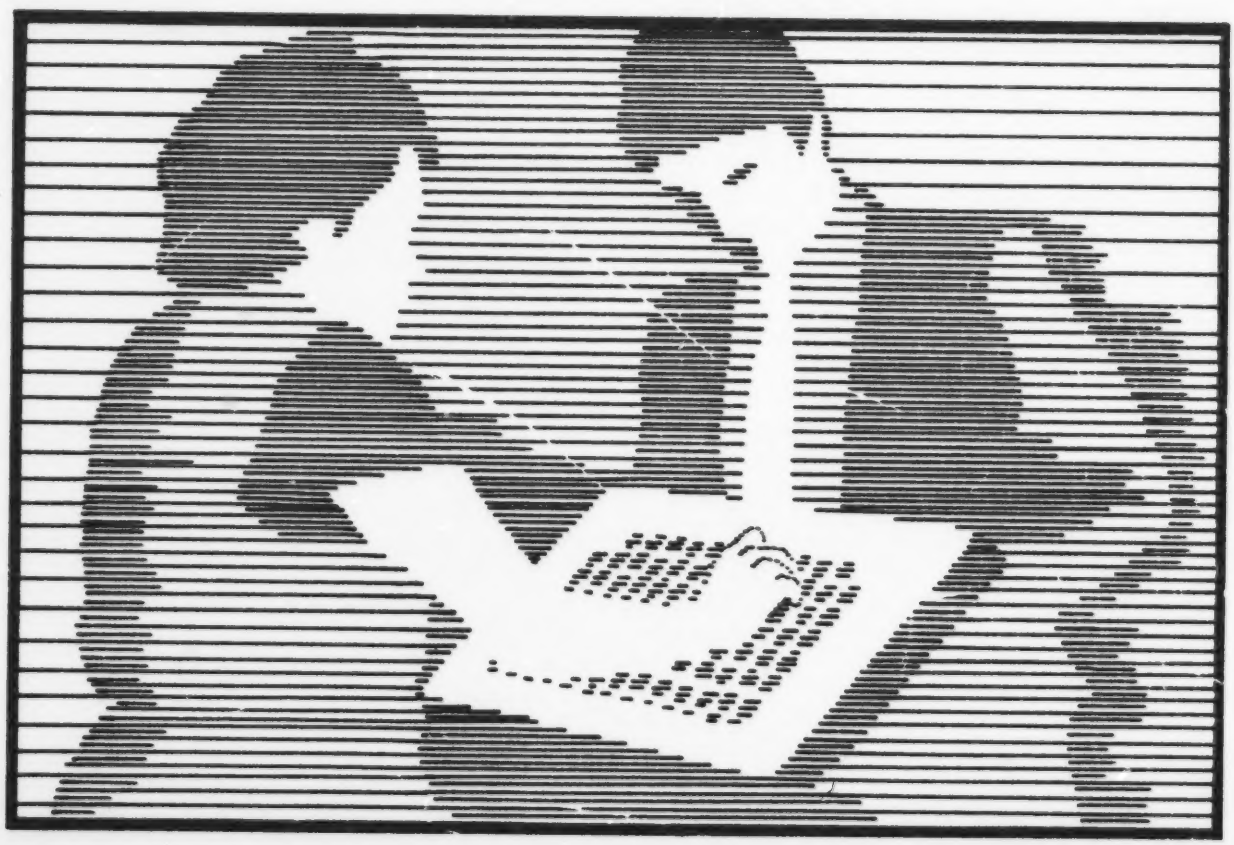
TP 5113 E

Human Factors of Technical Aids for Communication-Impaired Travellers



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November 1983

TP 5113E

Human Factors of Technical Aids for Communication-Impaired Travellers

prepared for

The Transportation Development Centre
Transport Canada

by

U. Rutenberg
A.M. Rutenberg

Les Designers Douglas Ball Inc.

November 1983

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17. Abstract

This report identifies and evaluates seven technical aid devices used by communication-impaired people. Although each device tested was designed for a specific purpose, the attempt in this study is to analyze utilization (human factors) of these devices within a travel environment - specifically Montreal's Dorval Airport and Central Train Station. Five communication-impaired volunteers (cross-section of sight, speech and hearing loss) were asked to simulate arrival/departure procedures within the terminal. Data were then collected, based on observation and interviews with volunteers and carrier personnel with whom they came into contact. Four of the devices - the Visual Ear, Form-a-Phrase, Vocaid and the Canon Communicator - were tested as two-way communication devices, providing interchange between the passenger and carrier agent or other terminal staff. Two techniques - Image Amplification and Infrared Radiation Broadcasts - were examined for use in one-way communication.

The primary conclusion of the study is that existing devices cannot be applied to the travel environment with its many distractions without major modification. Adaptation of such devices would be necessary to meet user requirements with respect to weight, portability, expanded capabilities, and ease of operation.

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17. Résumé

Ce rapport traite du projet qui a permis de reconnaître et d'évaluer sept aides techniques destinées aux personnes ayant des difficultés à communiquer. Même si ces aides sont conçues pour un usage très particulier, le but poursuivi n'en a pas moins été d'analyser leur utilisation dans un contexte pratique, celui de l'aéroport de Dorval et de la gare centrale de Montréal. Cinq volontaires représentifs de la population souffrant d'un défaut sensoriel (vue, ouie) ou d'élocution verbale ont simulé un départ ou une arrivée dans ces installations terminales. Les observations faites sur place et les interviews auprès des volontaires et du personnel des transporteurs ont permis certaines constatations. Quatre d'entre elles ont été mises à l'essai: le Visuor, le synthétiseur de parole Form-a-Phrase, Vocaid et enfin l'appareil à ruban Cannon. Fonctionnant dans les deux sens, ces aides permettent aux passagers de communiquer avec les agents et le personnel des transporteurs. Deux autres appareils de communication unidirectionnelle ont été essayés: un appareil optique donnant une image agrandie des imprimés et un système de transmission par rayonnement infrarouge.

Les conclusions préliminaires confirment que ces systèmes de communications ne sauraient être utilisés dans le contexte d'un voyage réel, sans avoir auparavant subi de sérieuses modifications quant au poids, à la maniabilité, la facilité d'emploi et la polyvalence.

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SUMMARY

This report is a result of a study undertaken by Les Designers Douglas Ball Inc. to assess the human factors of communication aids used by special need travellers in transport terminals.

The study consisted of:

1. a technical investigation of existing communication aids being used by travellers who have varying degrees of sight, hearing and speech loss.

2. a human factor analysis and evaluation of these products as seen in action at Dorval Airport and Montreal Central Station. Arrival and departure procedures were simulated with the help of communication-impaired volunteers and carrier personnel.

The data obtained formed the basis for our recommendations:

1. modification of certain products

2. new design approaches for other pieces of equipment

3. updated procedural requirements

4. follow-up studies, due to the limited nature of this study

5. international investigation of communication products and facilities, along with their interchange capability

The Study

Seven products on the market were tested. Five volunteers were selected and asked to use these products in a real-life situation - simulating arrival/departure procedures at Dorval Airport and Montreal Central Station.

Rather than collect data through a questionnaire, observation and interview techniques were used to record volunteers' perceptions on handling the equipment. The same process was used with carrier personnel.

The volunteers and personnel were unfamiliar with the technical aids being tested. Therefore, no stringent arrival/departure procedures were followed. Rather, each person first familiarized himself with the product, tried using it under a variety of conditions, and then commented on its use.

Because most travellers are not aware of the availability of technical aids like visual ears or amplified phones in public terminals, a small chart with symbols for eye, ear and mouth was displayed on the information counter. Travellers approaching the counter could then identify their problem by pointing to the chart, and indicating which impairment was involved.

During the course of the study the following human factors were analyzed: ease of handling, over-all use, operation, height, light requirements, colour, weight, and size. Portability and stationary use were also examined and commented upon.

The Conclusions

General

Lack of information on availability of technical aids is a serious deterrent to their effective use. The recommendation is to post signs and/or message centers at entrances and over counters, where applicable.

A specific counter, booth or other designated place is recommended as a centralized point to 1) identify oneself and the communication problem 2) access equipment on a loan or rental basis and 3) meet with trained carrier personnel who can respond to any travel-related problems.

Most of the equipment worked for the purpose for which it was designed. However, under the auspices of the travel environment with its accompanying distractions, major modifications would be needed to properly utilize these technical aids.

Improvements suggested by volunteers and carrier personnel included: utilizing the aid in a specific place, at the right height, under the right light conditions; having access to an aid from both sides of the counter or booth; and integrating the aid into a complete communication system.

Adaptation to the travel environment requires more than just state-of-the-art technology. Although some of the equipment tested could be suitably modified from a technical standpoint, a major conclusion of this study is that a problem area lies within the use of these devices: how they are obtained, how they are handled, how carrier personnel adapt to them as two-way communication exchange devices, and how passengers view them as an extension of their own sensory capabilities.

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1. INTRODUCTION

A study was undertaken for the Transportation Development Centre, in December 1982, to identify the number of communication-impaired persons there are in Canada, the type of impairment that would be categorized under this special need group, and the policies governing technical aids available to this group ("Communication Aids for Travellers with Sight/Hearing/Speech Disabilities", TP 3941E by IBI Group, December 1982). It was considered appropriate by TDC to conduct a follow-up study with the objective of identifying and evaluating the human factors of special need travellers actually using a selection of these technical aids. The travellers would have sensory impairments, varying in degree from partial to total loss of sight, speech and hearing. The objective would be to determine which technical aids could be used in transportation terminals and how easy they would be to handle and operate by travellers as well as by carrier personnel.

2. METHODOLOGY

In order to undertake these tests, five factors had to be considered:

2.1 The selection of volunteers with varying degrees in loss of speech, hearing and sight.
2.2 The selection of products considered best suited to a travel environment for both passenger and carrier personnel.
2.3 The selection of test sites to simulate typical communication problems, including ambient noise, crowds, visual and audio pollution.
2.4 The design of test procedures to observe and evaluate each product for its suggested use, to find out its compatibility with other existing systems.
2.5 The recording of results to enable the evaluation of data as a base for recommendations on products, procedures and new design approaches.

2.1 Selection of Volunteers

Five volunteers were selected according to type of sight, hearing or speech impairment; not by age, sex or other physical abilities. It was assumed that these people would be able to travel alone with little physical assistance, but would have problems communicating in a terminal. The degree of impairment chosen was at the higher end of the scale so they would have no choice but to communicate by some technical device or human aid. One of the volunteers who was almost totally blind had extensive travel experience. The other four had limited experience in travelling by train and plane, but greater exposure to daily transportation by bus, taxi and metro. Aside from one sight-impaired traveller who used a white cane, our volunteers were not perceived publicly as having any physical or other problems. (Table 1)

SUBJECT CHARACTERISTICS

SUBJECT	M/F	AGE	IMPAIRMENT	AID
A	M	50	- almost no sight (20/400) - ability to detect shadows, some colour	none
B	F	30	- hearing and speech difficulty - ability to read lips - some paralysis in left arm and hand	hearing aid
C	M	30	- limited hearing and speech difficulty - ability to read lips, use sign language	glasses
D	M	40	- sight and hearing disability with loss of peripheral vision	white cane
E	F	50	- speech impaired - uses writing pad	none

TABLE 1

The volunteers had the following characteristics:

A: Male, approximately 50 years old, almost totally blind (20/400), could read with one very strong amplifier glass to one eye at a distance of 2.5 cm, could make out shadows and light, could recognize colours only at short distance (green light of 25 cm x 25 cm at 60 cm), but could walk through a terminal with considerable ease; did not use a cane or dark glasses; identification of blindness was not possible by other passengers or carrier personnel.

B: Female, approximately 30 years old, could hear only with hearing aid hardly visible, had slightly impaired speech, could be understood if not in a hurry, could lip read; had some paralysis of the left hand and arm but otherwise an extremely active person. Could not be identified as having communication problems.

C: Male, approximately 30 years old, uses glasses, very limited hearing, could lip read and use sign language for communication. Limited speech, could not be understood on a phone. No other physical disabilities; not visually identifiable as being communication-impaired.

D: Male, approximately 40 years old, uses white cane; sight and hearing could be impaired unpredictably for a length of time (periods of 20 minutes or longer); has only a narrow viewing angle.

E: Female, approximately 50 years old, speech impaired, uses writing pad for communication; physically and mentally capable; has been impaired for only three years.

2.2 Selection of Products

The products were selected according to their use and hopeful ease of operation in the travel environment. Other important points in selection were their suitability for stationary and portable use, as well as probability that they would be used for communicating with another person or another system (the PA Systems).

None of the products on the market were specifically designed or developed for the travel environment. They were designed for personal use in institutions, homes, hospitals, etc. and were probably not developed by manufacturers to be used in public (e.g. terminals, shopping centres, restaurants).

All products except two (one prototype under development by B. Wright of Commetrics Limited and the Visual Ear by Bell Canada) are imported from the US or Germany. They are readily available and easily serviced by various distributors.

Prices were not considered at this time given the small quantities in use and the assumption that most products would require some modification for the travel environment.

These aids were also chosen for multiple use; that is, for more than just one impairment.

The following is a list of products chosen (Illustration 1):

a) Visual Ear
b) Form-a-Phrase
c) Canon Communicator
d) Vocaid
e) Apollo Imager
f) Infrared Audio System

2.3 Recording of Results

The test results as well as comments and recommendations were recorded and, in some cases, taped. This allowed us to go into greater detail for our final report. It was also particularly interesting to note on the tapes the high level of voice pollution prevalent in large terminals.

2.4 Selection of Test Sites

Two sites were chosen, Dorval Airport and Central Station, both in Montreal, respectively representing typical large-sized air and train terminals. Since time and budget constraints did not allow for more sites, high volume and travel frequency were chosen over small and medium-sized operations. Previous studies conducted by our firm have shown that small and medium-sized terminals can more easily cater to the individual passenger so the worst situation was chosen. Once problems have been solved for a large-sized terminal, it is easier to scale down for small and medium-sized terminals.

2.5 Test Procedures

Except for the Visual Ear, which is available on request in some terminals, and a built-in volume amplifying device on public phones, no specific technical equipment is readily available to assist communication-impaired travellers. All products now on the market are designed for different purposes; either to be used at home, in rehabilitation centres or hospitals. The products were therefore chosen for their funtional potential and application for the terminals had to be simulated in most cases. Drawing up a fixed questionnaire was dismissed due to the fact that it was unknown if and how the volunteers could use the equipment. A framework of communication between traveller and personnel was developed on likely questions and answers that arise when travelling. (Appendix B and C)

For the airport it was assumed that the ticket had been bought beforehand and that the passenger would approach the check-in counter with his/her baggage.

Several reports on wheelchair travellers have suggested the need for lower counters to be able to face the agent. For the purpose of this study, this idea was incorporated into a "Communication Center" which would be a place for all passengers with communication problems to check-in, including tourists who do not speak either French or English. The counter would be equipped with a number of stationary and portable technical aids catering to different needs, and would have a trained person available for assistance. Starionary equipment

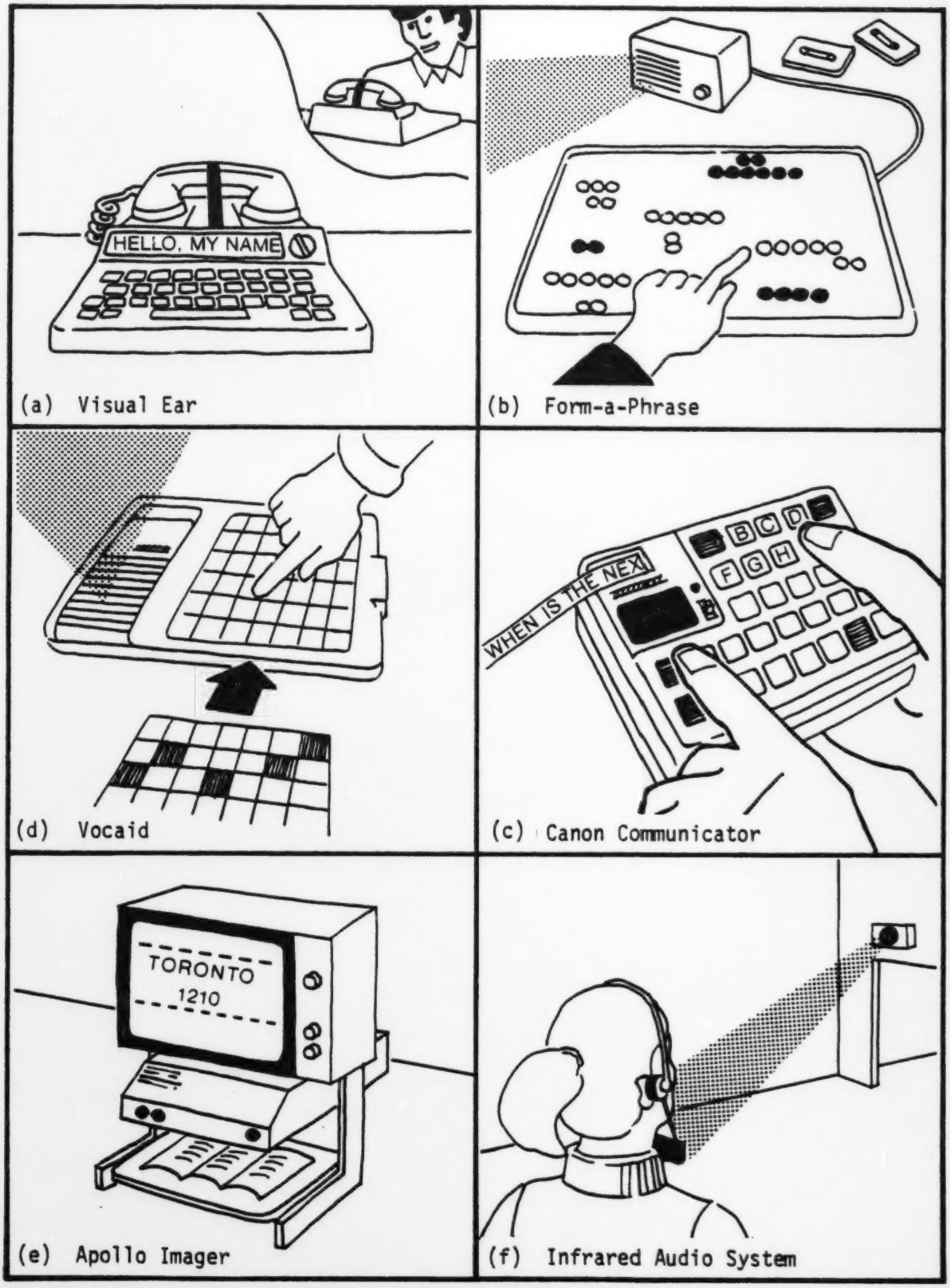


Illustration 1
Products Selected for Study

could be used immediately for communication. The portable devices could be on loan, used throughout the terminal, and given back upon boarding the aircraft or train.

As mentioned in almost all reports on special need travellers, IDENTIFICATION is a major problem for people with imperceptible impairments, such as those related to hearing, seeing and speaking. As one possibility for identification, a chart was prepared with hearing, sight and speech symbols and placed on an improvised counter. A passenger would approach this counter, pointing to one of the symbols. The person behind the counter could then immediately know how to help that person. For the blind, their symbol could be raised, or set in braille. (Fig. 1)

Fig. 1 - A chart was designed for identification of impairment

It was also assumed that for basic communication, certain keywords are necessary, and could be abbreviated. Instead of asking "Would you like a seat in the smoking or non-smoking section", the question could be reduced to "smoking" or "non-smoking", thus simplifying product function.

The products were then tested one by one, improvising the most stringent needs such as operational height, distance to eye or direction of speaker. In most cases the device had to be looked at by both the passenger and the carrier agent from the same side because it was difficult to turn the device around on the counter.

Many conditions could not be simulated. Lighting, for example, is very important not only when it comes to the use of these devices by sight impaired, but also for lip reading and sign language.

Both volunteers and carrier agents took time to get familiarized with each system, but they soon figured out how best to use the devices (e.g. using abbreviations, keywords, following the pointed symbol visually without waiting for the sound). All devices were quite simple to

understand and did not require a specific level of intelligence. Travellers were also asked to use the products before and after the test procedure to determine the potential each would have for his/her need. Some of the procedures were repeated, and positions of the device or location were changed on a trial and error basis to find out which way it worked best.

3. HUMAN FACTORS

"Human factors is a multi-disciplinary field, drawing upon all knowledge and understanding of the human condition. For any product to have meaning to the user, that is, to be both understandable and to 'stand for' or symbolize its purpose, it should penetrate into the human psyche, it should fulfill the basic needs of people to identify with self and with the designed world." (Archie Kaplan - "Designing with human factors is not a numbers game.", Industrial Design Magazine, January/February 1983.

The human neurological and sensory system translate into such human factors as PERCEPTION, THRESHOLDS, ATTENTION, VIGILANCE and so on. The human body acts as a differential detector, responding and giving attention to changes created in and by the product and the environment.

The prime human response to products and environments is emotionally viewed as a GESTALT. The effective questions asked are: What does the product do for me? How do others see me in relation to the product?

General product criteria from a broad view of human factors are:

A. FUNCTIONAL - the product should be easily understood for its purpose and use, and manipulated without discomfort. Its size and controls such as knobs, buttons, key, etc. should be ergonomically designed.

B. AESTHETIC - it should be aesthetically pleasing to prospective users in scale, proportion, colour, texture, etc.

C. SPYCHOLOGICAL - the product should be inviting to use and hold in apparent safety and security. It should be attractive without being too noticeable. It should give confidence to the susceptible user.

D. SOCIAL - the product should be socially and culturally acceptable in terms of today's values.

3.1 Discussion of Test Results

3.1.1 VISUAL EAR

Dimensions - 23 cm x 18 cm x 5 cm (9" x 7" x 2"), weight approximately 1.4 kg (3 lbs); powered by standard 3.5 mm plug, AC adaptor, rechargeable nickel cadium batteries, optional printer, colour - dark brown.

The Visual Ear is best known for its application as a phone for people who have hearing and/or speech impairments. It requires a device at each end similar to a telephone. In any given conversation the message keyed in by one party is displayed on both instruments. It is replaced when the other party keys in a response.

The purpose of this test was to simulate the use of the Visual Ear as a communication device at a check-in counter or at an assumed "Communication Center". Different people, some with hearing loss, some with speech impairments, used the Visual Ear with ease after some practice. It is easy to use if the person is able to operate a keyboard, or if he/she is not visually impaired. The operation of the device was good at a standing height of approximately 76 cm (30"). The typical counter height of 122 cm (48") offered some difficulty in operation in that the arm must be maintained in an uncomfortably raised position for the length of the typing. This difficulty disappears if the counter is lowered to 76 cm (30"), increasing the legibility of the letters and helping the typing accuracy. (Fig. 2)

Fig. 2 - Test of Visual Ear at airport check-in counter

For counter personnel there was no problem except for operating height. Time for communicating was increase by using abbreviations since there is only one line with 24 characters on the screen. The graphic presentation of the letters gives good legibility. There is a soft touch to the keys, and the white letters on brown background are slightly raised, making it easy to find them. In Dorval Airport, the device was tested under daylight conditions where bright sunshine and shadows create strong contrasts not ideal for using a dark-coloured keyboard. Lighting condition in general are quite poor and should be improved; ambient as well as task lighting.

The major problem of the Visual Ear is the constant need to turn the device around back and forth between the "Questioner" and the "Respondee". It almost requires a side-by-side arrangement. Apart from this, it was found to be a useful device by the volunteers and the carrier personnel, allowing for very precise communication. The principle is recommendable as a stationary device on the counter. Language is no problem. (Fig. 3)

Fig. 3 - VISUAL EAR

3.1.2 FORM-A-PHRASE

Dimensions - 56 cm x 48 cm x 6 cm (22" x 19" x 2 1/2") (board), weight approximately 1 kg (2 lbs), main unit - 10 cm x 20 cm x 12 cm (4" x 8" x 5"), can be used with speaker or with earphone, colour - light beige/grey, different overlays.

The large dimensions of the word board and weight of the main unit make it preferable for stationary use on a counter or table.

Form-a-Phrase is designed to satisfy the communication needs for speech-impaired persons. It also permits effective use by deaf or paralyzed persons.

It consists of a board with 128 round fields, connected to the main unit by a cable. This unit produces a human, taped voice by touching a specific field on the board with a magnet.

The main unit is battery charged and an earphone can be connected for better reception, making it portable to some extent.

The magnets come in a variety of holders and allow people with manual dexterity problems to pinpoint the chosen field. Each field represents either a word, or a part of a sentence or symbol, depending on the overlay. Time sequence between words and voice volume can be controlled, so that the disabled person can operate at his/her own pace. (Fig. 4, 5)

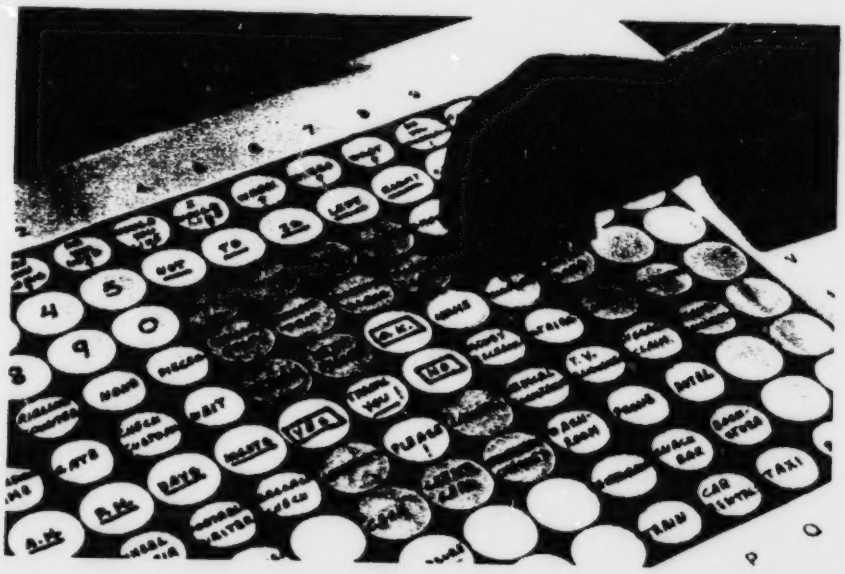


Fig. 4 - Form-a-Phrase overlay

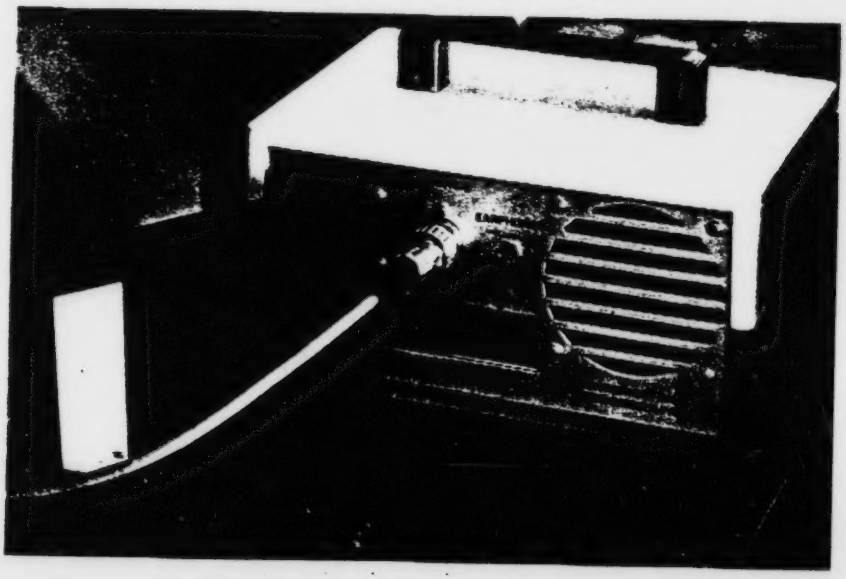


Fig. 5 - Form-a-Phrase voice control

In the beginning volunteers were confused by the amount of fields from which to choose. A few minutes learning time was required to find out the grouping of questions, sentences, etc.

For a good overview of the board, viewing distance of approximately 76 cm (30") is best but for reading the individual fields one has to get closer, approximately 35 cm (14") depending on eye sight. Lighting conditions play an important role as does good visual design of the overlay. The fields could be grouped by questions relating to ticket, gate, travel, facilities, and numbers; colour coding could also play an important role.

For this study an overlay with the most common vocabulary for in-terminal dialogue was developed, simulating typical questions (e.g. "smoking?", "non-smoking?", "window?", "aisle?", "where is?", "when?", etc.). The colour-coded arrangement was helpful but could be further developed

Because of the time factor, a tape of this special developed overlay was not recorded. However, for this test a dialogue between the agent and volunteer was possible even without a taped voice.

In the case where a passenger cannot speak but can hear, the dialogue partner reads the field while the passenger touches it. For this type of communication both persons involved would have to face the overlay, in which case the counter would have to accommodate this position. (Fig. 6)

A suggestion for lighting the touched fields for better recognition was made.

Fig. 6 - Form-a-Phrase "dialogue"

It was also felt that for people who cannot use their hands, a head pointer could be used instead. An overlay mesh which has a lip around each field would help to guide them into the chosen field.

The amount of fields could probably be reduced narrowing down the complexity of the total board. The size of each individual field could be slightly increased to allow for English and French printing at the same time. In the case of a hearing impairment, half of the board could be left for typical answers by counter personnel. Viewing of the board by both passenger and counter personnel would increase the speed of communication. Otherwise, the whole board must be turned around.

A case was also simulated with one of our staff members in a wheelchair putting the board on his armrest. It was easy to work but it would require the removal of the device from the counter to the wheelchair. It would be better to have the counter designed in such a way that it would accommodate a wheelchair passenger at a height of approximately 76 cm (30") with knee and leg space underneath. (Fig. 7)

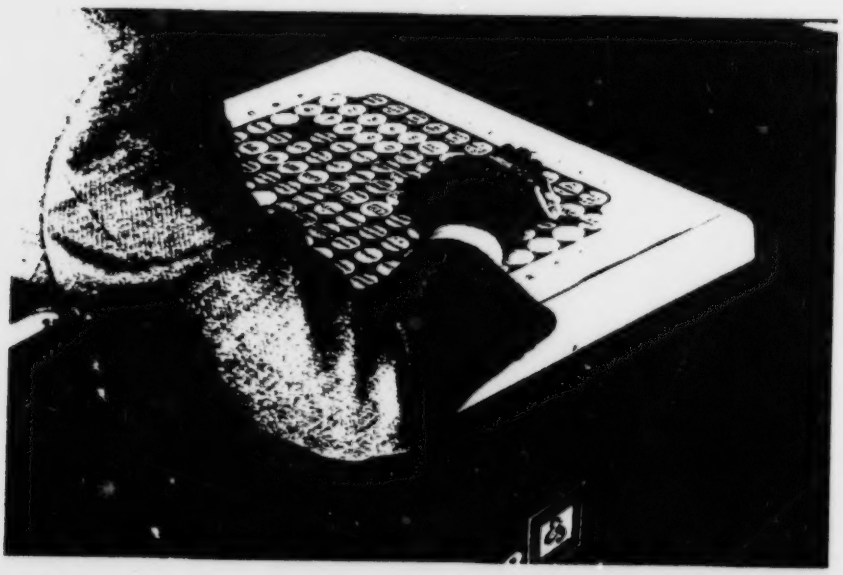


Fig. 7 - Form-a-Phrase operated by wheelchair user

Our test showed that people with hearing impairments preferred a "visual" answer, such as pointing to a field or having the field lighted due to the fact that most are unable to separate ambient noise from the spoken word. To prove this point a sound tape was made at Dorval Airport which revealed a tremendous amount of noise not always noticed when communicating over the counter. The point is that our brains have a digital filter programmed to reject unwanted information. If this filter is not working all oral information comes in with the same priority. In the case of hearing impairments the filter is affected, giving free entry to all oral information.

Dialogue using the speaker was more time consuming than a spoken dialogue. But taking into account that the device could be used by travellers with restrained manual dexterity, quadriplegia, or travelers who could not type, speak or hear, the time factor seemed irrelevant.

3.1.3 CANON COMMUNICATOR

Dimensions - 13 cm x 9 cm x 3 cm (5" x3 1/2" x 1 1/4"), weight approximately 250 g (10 oz), paper strip - 10 mm (3/8"), needs a charger, separate attachments to arm, belt and wheelchair available.

Because of its compact design, its dimensions and weight, this device is recommended as the most portable. It can be hand-held, used on a table top or attached to an arm, wrist, belt or wheelchair. It allows use with one hand only and, because of its printer, it permits preparation of written messages prior to communication. For successful use of the device, some skills are prerequisite (e.g. good finger control, typing and spelling ability). It is meant for use by people with speech or hearing impairments.

This device offers a great range of use. When fully charged the communicator operates up to seven hours with a printing rate of one character per second and a paper roll of sufficient supply (12,500 characters). It permits the traveller to communicate regardless of his/her location (e.g. at a counter, in a restaurant, plane, train, shops, etc.). It was tested at the check-in counter at Dorval Airport, the counter in Central Station and with Redcaps. The possibility of writing any message gave great freedom of communication. (Fig. 8)

Fig. 8 - CANON COMMUNICATOR

The appearance of this communicator appealed especially to our younger volunteers because it looks similar to pocket calculators. Colours are light grey with dark grey and orange highlighted keys. The casing is molded plastic and is comfortable to the touch. Its size allows for easy carrying in a purse or briefcase. As a portable communicator device it combines usefulness with current technology.

The volunteers as well as the carrier agents were confused by the layout of the keyboard. It did not follow a typewriter layout. Vowels were highlighted in orange which was found unnecessary by all users. Layout similar to a typewriter would have been preferred. Another alternative would be keys in alphabetical order. Touch-sensitive keys were welcomed. The keyboard offers capitals and numerals. The legibility of the keys was found acceptable.

A keyboard overlay allowed for recessed keys and helped people with manual dexterity problems. The finger can slide into the key depression although travellers with a head pointer might find them a bit small in diameter.

The printout message on the paper strip lacks colour and contrast. To read it, one has to hold it at about 30 cm (12") from the eye. Letter size should be bigger, and contrast stronger. The paper can be torn off, something which was difficult for those who had manual dexterity problems. A mechanical cutting device would be more appropriate.

The possibility of tearing off the printed message permits face-to-face communication. This allows physical distance between two people and gives time to observe reactions to the printed message.

Two situations were tested: one, where the passenger was speech-impaired but could hear; the other, where the passenger was both hearing and speech-impaired. The first situation required that the passenger print the message, hand it over and receive the answer in spoken form. To print the message the device could either be attached to his/her arm, wrist or wheelchair, or placed on the table or counter. The device works well for both left and right-handed people. Stability could be improved to avoid sliding on a surface. The charger can be hooked onto a pocket, belt or shirt. Communication with the Canon Communicator worked well with carrier agents and Redcaps. (Fig. 9)

Fig. 9 - Canon Communicator with charger

In the second situation a different set-up is required. The printing of the question is the same, but the answer by the carrier agent or the Redcap has to be given with the same device. For this situation the arm attachment has a disk that allows the turning of the communicator by 180° to face the other communication partner so he can type the answer. Observations here showed that this does not present a functional problem, but a psychological and physical one. The physical distance between communication pertners becomes critical, especially between male and female, and is not wanted in most cases. Volunteers preferred to unhook the communicator plus charger and hand it over to the other person in order to keep comfortable physical distance and personal territory. (Fig. 10)

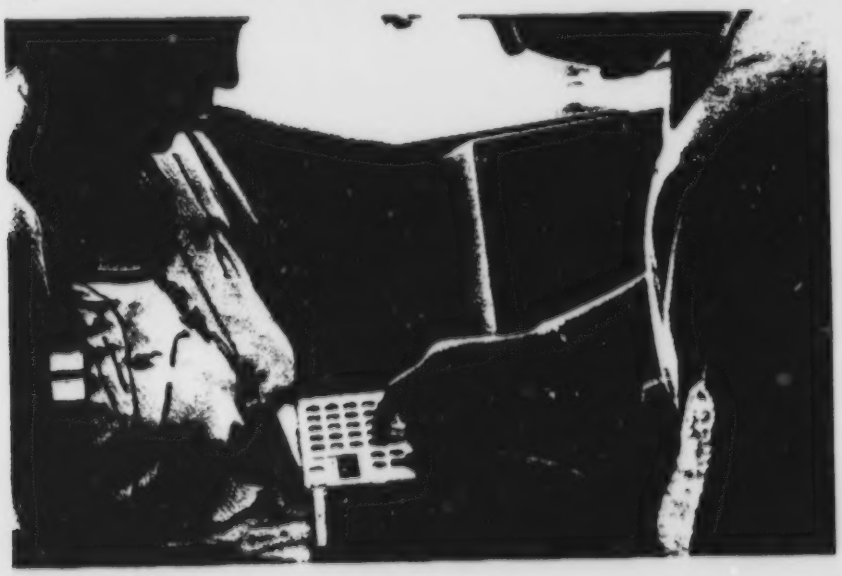


Fig. 10 - Canon Communicator used by carrier agent

3.1.4 VOCAID

Dimensions - 37 cm x 25 cm x 4 cm (14 1/2" x 9 3/4" x 1 1/2"), weight 250 g (10 oz), powered by 2 - 1.5 volt batteries, built-in synthesized voice.

Similar in function the the Form-a-Phrase board, this is a smaller portable communication device with a synthesized voice output. Directed to speech-impaired people this aid may assist persons with short-term speech loss, such as stroke victims, tracheotomy patients as well as the permanently speech-impaired people. Its compact size and weight makes it comfortable to carry. The plastic-formed casing, the finish and the rounded corners give a pleasant and clean appearance. It is powered by two batteries or can be connected to an AC adaptor. The Vocaid can be operated on a counter or table, hooked onto a wheelchair, hand-held, or used on a lap.

The vocabulary is very limited (24 fields for questions and statements, 10 numerical fields and 2 fields for on/off). Communication is one-way only; that is, the user can ask questions like "where is the washroom?" or statements like "I am tired" but the other communication partner cannot answer because only the words printed on the overlay are recorded. (Fig. 11)

Fig. 11 - Vocaid with medical overlay

The device has 36 fields with the present design. Each field is touch-pressure sensitive and produces a voice. There are four different overlays not relevant to travel. This can be easily modified by changing the program. From the four overlays which are available, one was related to medical attention and was tested in the clinic at Dorval Airport and at the CN clinic in Central Station. Nurses in both clinics would welcome such a device. (Fig. 12)

As a general portable device it was found to be useful but because of the number of fields (36) communication is limited. The fields are square with round corners and have a raised lip around them. The lip is good because it helps the finger stay in the field. Although a square offers more printing surface, a circle would be more useful to help center the finger or head pointer.

Fig. 12 - Vocaid testing at airport clinic

Learning to use the unit was quite easy for all volunteers since there is only a limited number of fields to oversee. Reading of the fields was good for all except one person with a strong sight impairment. He would have preferred a braille or raised symbol indicator for each field.

The overlays can easily be changed by lifting the cover and snap-pint them into receiving pins. Each pin set triggers a different program for the voice output. The pressure to activate the field is adequate. After 2 1/2 minutes on non-use the device switches itself off automatically; a good idea as it saves the battery. (Fig. 13)

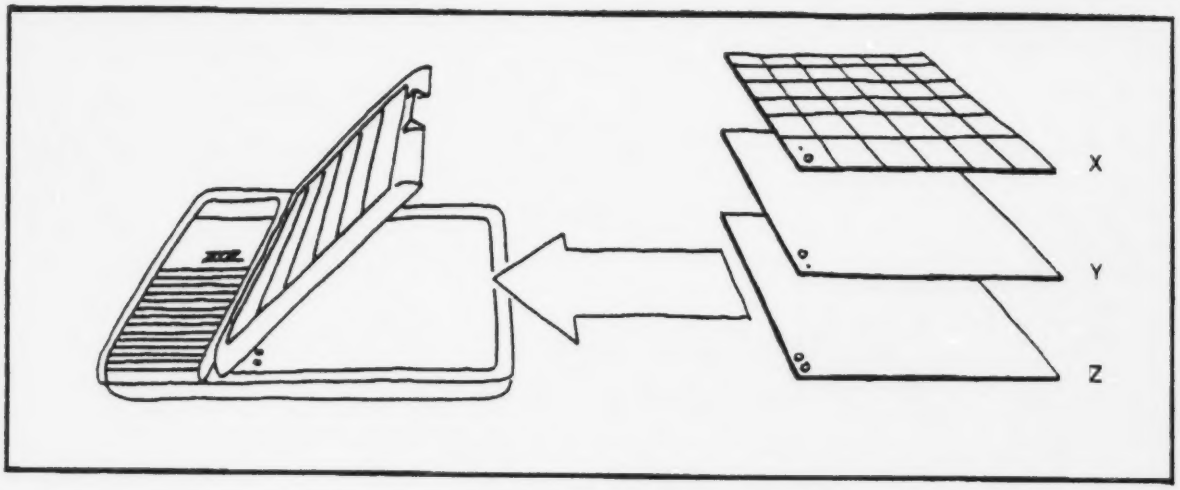


Fig. 13 - Vocaid with different overlays

The bone colour makes it look very light and discreet. Colour coordination of overlays was helpful. The medical overlay had different blue tones for priorities (e.g. all emergencies dark blue, others lighter). Legibility was good but a study of the contrast between background colour and printed message would be useful for the future.

The synthesized voice, although metallic, was acceptable. Left and right-handers can operate the unit without problem. 10° to 15° inclination would increase the legibility of the visual field and would eliminate bending over too much. Also, at this angle, light originating from the ceiling would not reflect on the overlay. Basic communication time in emergencies would be shortened with use of this device. A nurse in Dorval told us that without a device, she needed twenty minutes to communicate with a patient suffering from a stroke-related speech impairment.

3.1.5 APOLLO AMPLIFIER

Dimensions - standard 50 cm (20") TV monitor with front controls, approximately 48 cm x 38 cm x 33 cm (19" x 15" x 13"), weight approximately 15 kg (30 lbs), camera takes a table space of 43 cm x 43 cm (17" x 17"), powered by 110 V AC, accessories available.

This electronic visual aid uses a camera, which pan/tilts 360° to read any written, drawn or printed matter placed under the camera. It amplifies the original up to 60 times on the TV screen. The message can be seen on the TV screen black on white, white on black, upside down or left side right. Focus, zoom and contrast can be controlled manually.

This device can be used for sight-impaired people who can read at a distance of approximately 12.5 cm (5"). It could also be used by hearing-impaired and partially sight-impaired people to communicate any written message, such as plane or train schedules. For almost all people who have difficulty reading fine print, this would be a helpful aid. (Fig. 14)

Fig. 14 - Apollo: amplifying simulated boarding pass

This device was found to be suitable for everyone to use at one time or another. Passers-by in Central Station were curious and used it for printed train schedules. The placing of the original underneath the camera and the movements of focussing and adjusting took only seconds to learn.

The lack of colour was a disadvantage for people who perceive colour contrast better than black and white.

Technology, however, is so advanced today that applying different colour contrast for better legibility should not be a problem.

A counter height of 75 cm (30") to 100 cm (40") is suitable for operation while standing. The camera table should have a lip or some other arrangement to prevent the originals from sliding off. A transparent glass or plexiglass plane to cover the original would also be useful to prevent distortions.

The counter height for wheelchair users should be approximately 70 cm (28") to 75 cm (30") which requires an adjustable table height. Location of the monitor should be above the camera in order to coordinate movements on the table in relation to the ones on the screen. A tilting monitor would be suitable for a wheelchair user who cannot bend his head too far back.

The model which was tested had the monitor sitting on top of the camera stand. Other models are available. The unit is styled more for residential use because of the appearance of woodgrain finish casing. The design lacks the quality of a homogenous unit. Instead, it looks like separate elements purchased at different places.

3.1.6 INFRARED AUDIO AMPLIFICATION SYSTEM

This Infrared System is based on the same principle as all audio amplification systems (e.g. Induction Loop, AM Broadcast and FM Broadcast Systems). The Infrared System was developed for hearing-impaired persons who can hear with the help of audio amplification. It can also be used by sight-impaired persons to receive auditive information.

The transmitter/receiver principle is the same in all systems, only price, sound quality and appearance vary. What matters to the user is the end product which is the quality of the sound he receives and the degree of difficulty he has in controlling it.

The system consists of a number of infrared transmitters which can be positioned in key places in a terminal. These transmitters emit travel information similar to a PA System to the receivers. Receivers are worn by the travellers to obtain auditive messages. The receivers are either earphones or hearing aids connected.

In order to evaluate human factors, emphasis was placed on the receiver. A typical infrared system was chosen but could only be simulated since installation would be costly and time consuming. (Fig. 15)

Fi.g 15 - Infrared Audio Receiver

According to hearing-impaired experts, infrared systems produce the best sound quality. The use of two receivers was simulated: a battery-powered unit with earphones, volume control and an on-and-off switch; and a hand-held unit to which a hearing aid was connected.

The design and appearance of these units is quite appealing to the younger generation since many use "walkman" stereo units. The visual appearance of someone using a headphone in public is commonly accepted. Someone in a terminal or on a plane using a headset to hear music or a movie soundtrack would not be visibly labelled as a special need traveller.

Receivers are portable and could interface with a PA system that transmits messages such as delays, paging, changes, etc.

The two receivers that were tested had both an "on" and "off" switch but no light, vibration or any other control to indicate when a public message was being transmitted. In order not to miss a message, the receiver had to be on at all times consuming battery power. With today's technology, a light could come on for the hearing-impaired people approximately 15 seconds prior to the message, and for the sight impaired a vibrating control could be activated to indicate the same.

The receiver could be loaned at the "Communication Center" and returned when boarding or, after using it on the plane, returned when leaving the aircraft or train. Once a suitable system is standardized for all terminals, the passenger could interface with his/her own aid.

Using the combined earphone and receiver in the first unit was easy because one had both hands free. The unit which had the receiver and hearing aid separate required the use of one hand. Placing the earphones in the ears, as well as taking them off, did not create a problem for people who can use both hands. The on-off switch was neatly designed with a yellow strip on flat black background to give good contrast. Plugging in the wires to the hearing aid was a bit difficult because plug and receiving holes are quite small. One needs a steady hand.

3.1.7 ACOUSTICAL FINDER

Although still in the prototype stage (by Bob Wright of Commetrics Limited), this Acoustical Finder was included in the test for its future potential.

The Acoustical Finder is a device developed for the sight impaired to facilitate their orientation.

There are very few technical aids available to enable the blind to become oriented in a large place like a terminal with all its architectural, technical and traffic elements. Testing could only be simulated since the system is based on infrared waves which require transmitters and portable receivers.

The idea with this device is to have an infrared transmitter installed over focal points in the terminal such as exits, information center, check-in, staircases, elevators, carrier gates, automatic doors and over facilities such as washrooms, phones, restaurants, book stores, etc. Each transmitter would be programmed according to its location.

The receiver is a small hand-held device with a built-in speaker that, when meeting the infrared beam of a transmitter, porduces a two-second message (e.g. "exit", "washroom", etc.). This voice can be programmed in any language and be received directly over the built-in speaker with volume control, or heard through an earphone or hearing aid.

The more the receiver is pointed in direct line to the infrared beam, the more precise the location of facilities can be determined. A further development could include an indication for distance (e.g. one beep 15 m (50 ft), two beeps 7.5 m (25 ft), three beeps 1.5 m (5 ft)). This could be a great asset for the sight impaired.

This device could be made available to passengers at the "Communication Center" on a loan basis and returned when boarding. It could also be further developed for use in the aircraft or train to indicate washrooms, exit doors, or dining car.

The appearance could be similar to modern "walkman" radios with headphones to blend in with today's social values and technology. (Fig. 16)

Fig. 16 - ACOUSTICAL FINDER

4. CONCLUSION

Modern technology and the consideration of human factors in designing equipment could greatly facilitate communication-impaired traveller problems in terminals and their respective modes. This would, at the same time, reduce confusion, anger and frustration on the part of the passenger as much as on the part of the carrier .

The success of implementation depends on the consideration of human factors which were looked at in this study. At present, adequate equipment designed with human factors in mind does not exist for the travel environment.

We must bear in mind that none of the tested equipment was designed for travel. Only the principles of function were applied to simulate use. Principles such as the Visual Ear, the Form-a-Phrase, the Canon Communicator, the Apollo Amplifier and the Infrared System were found useful but none of the porducts can be taken as designed and placed in the travel environment. Technology, in some cases, is already obsolete (e.g. change of programs by cardboard overlays, use of cassettes, etc.). This study also revealed that, in order to improve communication, it is not just products that must be considered. The whole environment including agents, carriers, policies, attitudes, fellow passengers, existing communication systems and procedures must be examined because all play an important role. Human factors do not only consider the direct hands-on problems of a product. Characteristics such as anger, frustration, stress, insecurity and vulnerability resulting from various other inefficiencies, such as lighting conditions, noise, private space, glare, etc. must also be considered. Although these factors are only indirectly related to the equipment, they nevertheless contribute to the communication process.

In most cases, communication with a device requires the constant handing over or turning around of the device. The traveller and the agent standing or sitting side by side to view the device requires unwanted physical closeness.

In addition, the study made clear that sometimes voice output to keyed messages is not only unnecessary for use by sighted (e.g. Vocaid and Form-a-Phrase), but may actually slow down the two-way communication process. As both partners are sighted, both are visually following the keyed message. Lit keys, staying on for some seconds, may be more helpful because the message of the last key would still be visible, thus increasing communication speed.

For portability, the Canon Communicator concept would seem to be the logical direction for use in a terminal and on board, although the keyboard layout, its weight, size and handling of the paper strip resulted in problems for some of the test subjects. The Visual Ear should be used solely as a telecommunication device, since the handling in a

two-way communication situation required either constant turning around of the unit or intrusion on the personal space of each communication partner.

In the area of one-way communication for stationary equipment, results of the study suggest thet a device similar to the Apollo Amplifier would provide assistance to a large number of travellers, many of whom have difficulty only in reading small print. This set-up would have to be ergonomically studied and intergrated into a communication system.

Regarding the two infrared systems, it was found that travellers would not mind wearing headphone receiver sets similar in appearance to "walkmans". Their appeal is compatible with today's social values on such equipment.

In summary, results of the study suggest that human factors relevant to the terminal, the equipment and the procedures are all very important aspects. The communication-impaired traveller is probably under greater pressure than other passengers and is, therefore, more sensitive to communication inefficiencies. Available equipment is, in some respects advanced, while in other it is completely obsolete.

The study does indicate that current technology has strong potential for alleviating the communication problems of impaired travellers.

5. RECOMMENDATIONS

5.1 General

This study reveals that communication procedures coupled with the travel environment require a very specific approach to improve the situation for communication-impaired travellers.

There are no products available which, even though modified, would fulfill the requirements of the traveller in a terminal or on a carrier vehicle. Therefore, the following is recommended:

- Communication should be looked at from a systems' viewpoint including environment, traveller, carrier agent, policies, procedures, mode and complete trip. Isolated considerations would only bring limited results.

- Communication equipment with up-dated technology should be designed for use under conditions of comfort and dignity for the communication-impaired travellers as well as for tourists who do not speak either official language. Human factors such as personal space, manual dexterity, identification, viewing angles, reflection and glare, ease of handling and understanding of the equipment should be considered.

Only by addressing the complete package and their integral elements at the same time, can communication problems be alleviated and access to public transportation improved.

The technology is at our doorstep - it is easy to find what the user needs. The next phase is development and design in cooperation with all parties involved; the user, transport authorities, carriers and manufacturers.

Reducing frustration, misunderstanding and stress could make travelling a lot easier. Communication is one of the key elements towards the accomplishment of this goal.

5.2 Specific Suggested Improvements

Communication center. (Illustration 3)

Two-way, tilted communication device, with travel-related overlay. (Illustration 4)

Availability of aids and services made known through signs. (Illustration 5)

Identification of impairment at counter through signs and raised symbols. (Illustration 6)

Identification of imapirment made on ticket, by codes or symbols. (Illustration 7)

Communication devices for impaired available at counter. (Illustration 8)

Integration of Visual Ear into public phone system. (Illustration 9)

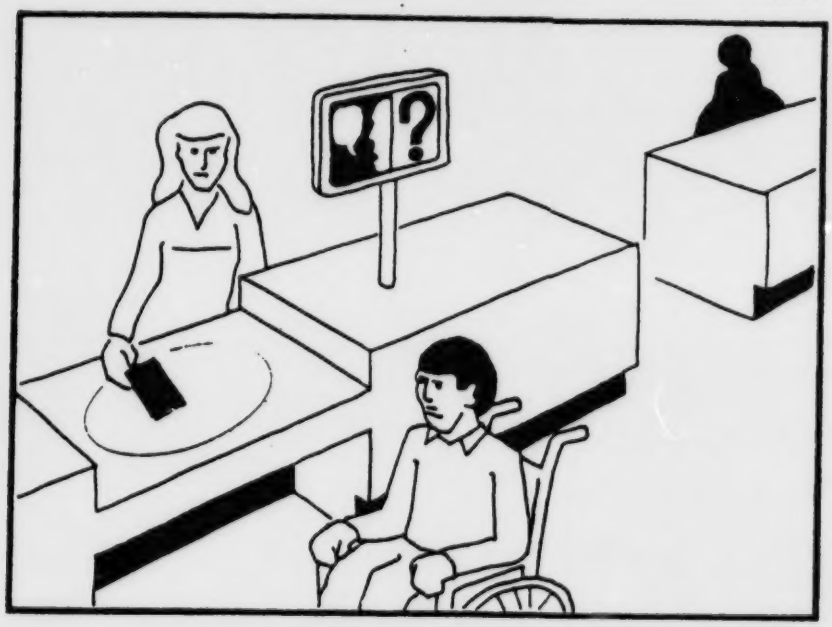


Illustration 2
Communication Counter

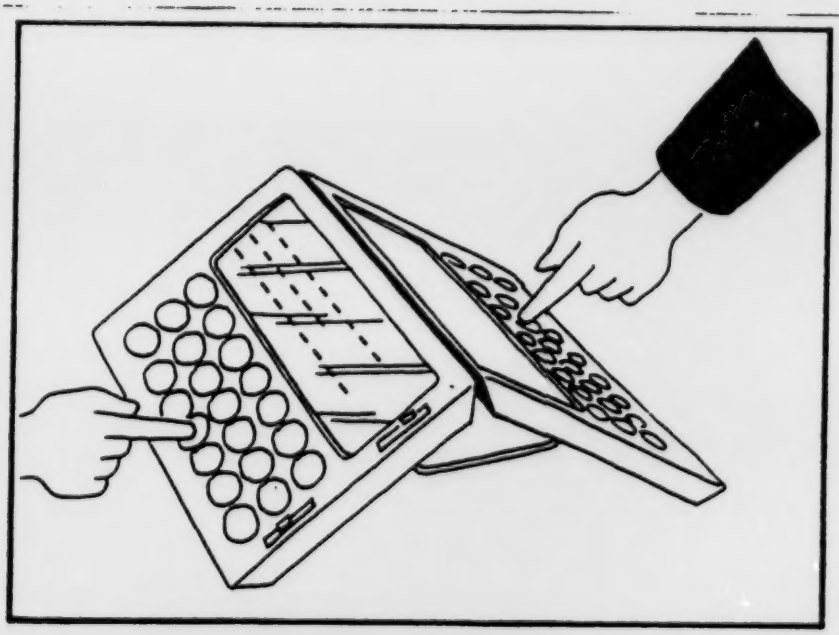


Illustration 3
Two-way, tilted communicator

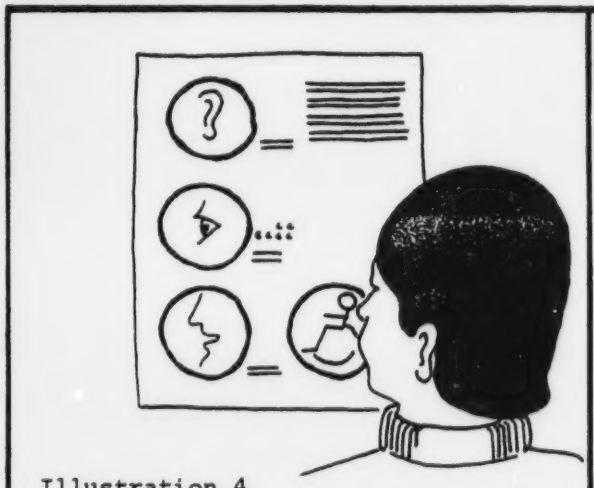


Illustration 4
Services available

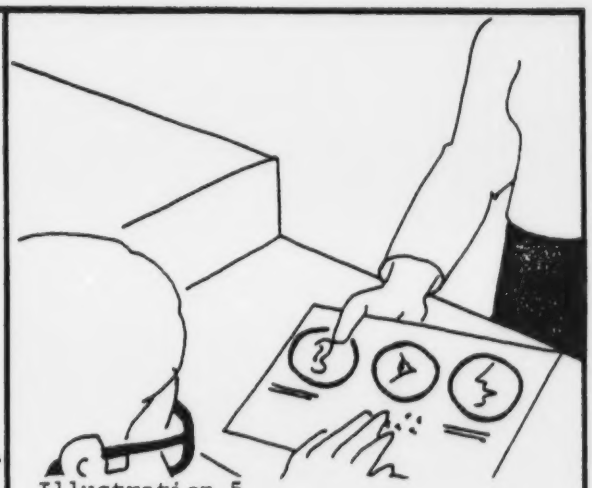


Illustration 5
Identification chart

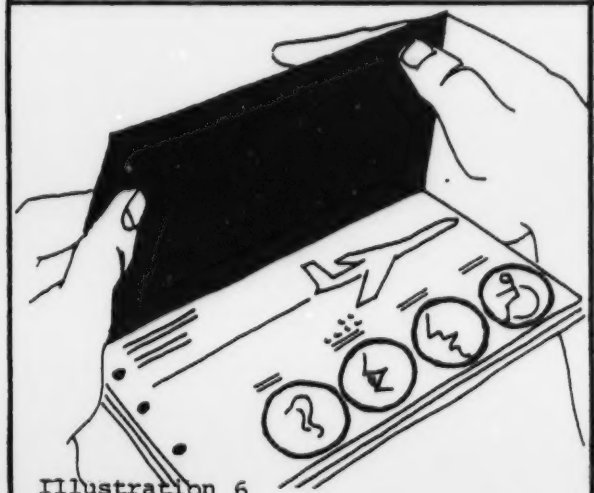


Illustration 6
Identification on ticket

Illustration 7
Communication counter

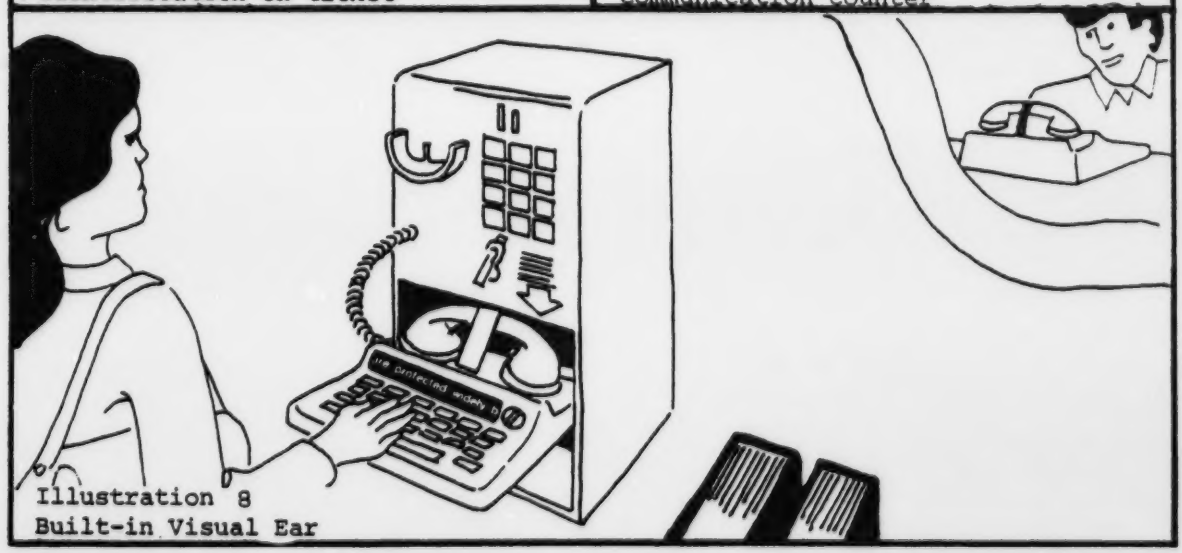


Illustration 8
Built-in Visual Ear

APPENDIX A - CHOSEN TEST PRODUCTS WITH DESCRIPTIONS

a) VISUAL EAR 23 cm x 18 cm x 5 cm (9" x 7" x 2"). Manufactured by Northern Telecom, distributed by Bell Canada, for use by hearing and speech-impaired people. It uses a standard typewriter (QWERTY) keyboard with one line LED message. It can be interfaced with a regular telephone but the other end must be equipped with the same device. (Fig. A1)

Fig. A1 - VISUAL EAR

b) FORM-A-PHRASE: 56 cm x 48 cm x 6 cm (22" x 19" x 2 1/2"). Plastic board with words, symbols or partial phrases for hearing and speech-impaired people. It produces a clear, human tape-recorded voice (not synthesized), when a circular area on the board is touched by a magnet. Time sequence of response and volume can be adjusted. A different tape is necessary for each overlay of symbols or phrases. There are 128 circles on the board. Voice output can also be connected to earphone or hearing aid. (Fig. A2, A2a)

Fig. A2 - FORM-A-PHRASE

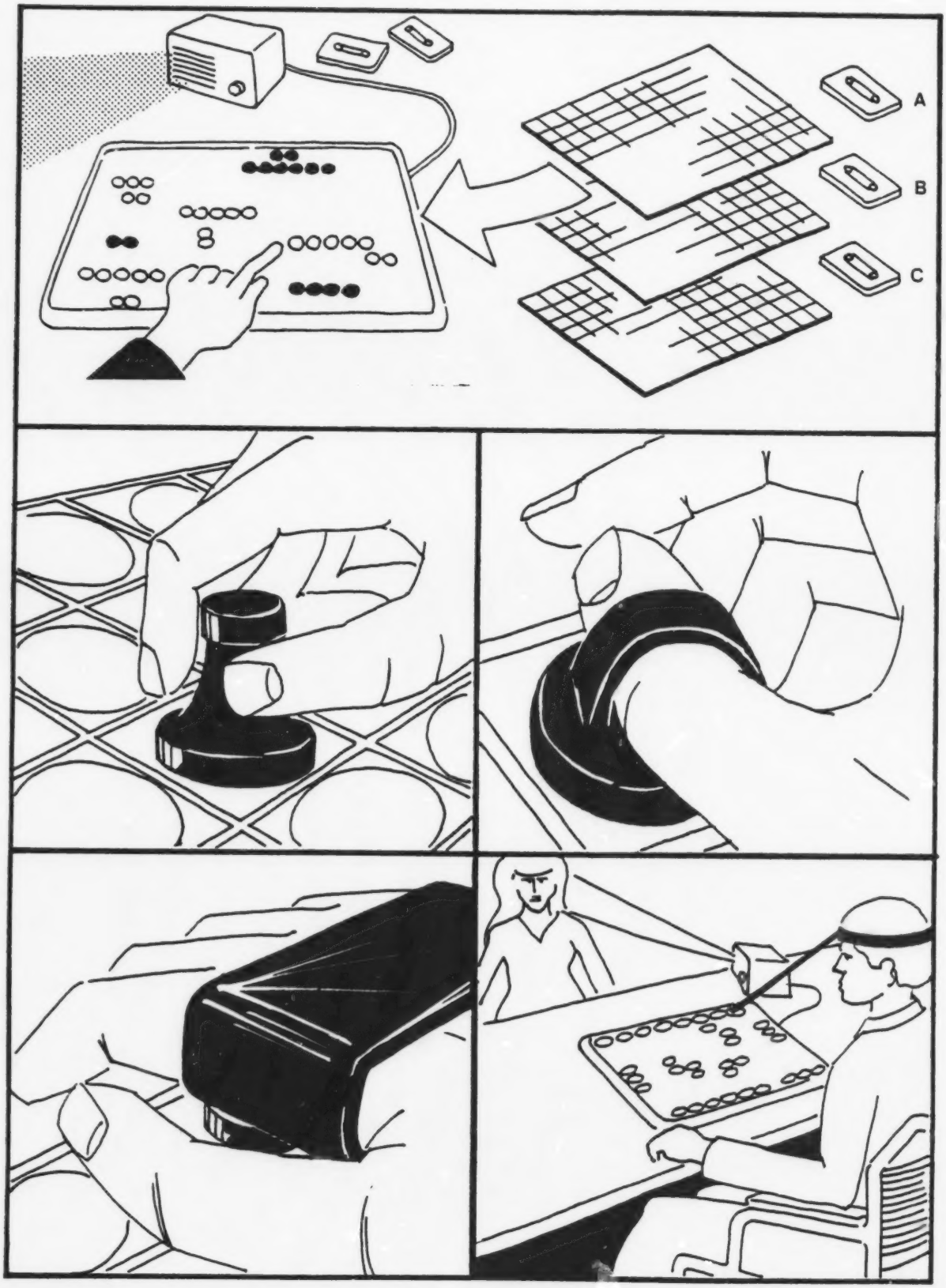


Fig. A2a - Form-a-Phrase

c) CANON COMMUNICATOR: Manufactured by Canon Limited, it is a small portable device for hearing and speech-impaired people 13 cm x 9 cm x 3 cm (5" x 3 1/2" x 1 1/4"). It is powered by a charger that can be put on a waist belt or in a pocket. An alpha numeric keyboard with receded holes, approximately 1 cm (3/8") in diameter, prints computer-like capital letters and numbers on a strip of paper 1 cm (3/8") wide. The paper strip can be torn off. The decive can be mounted on a wrist and turned around 180° so that an other person can key-in the answer. (Fig. A3)

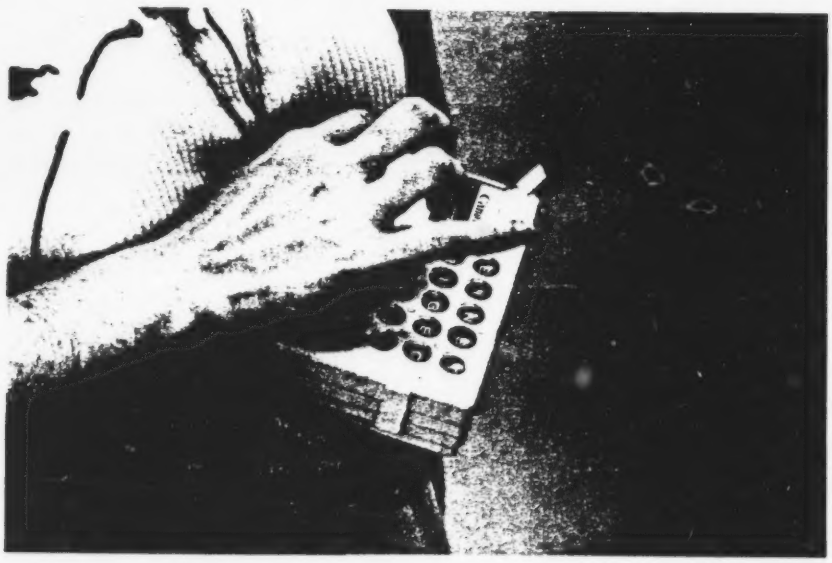


Fig. A3 - CANON COMMUNICATOR

d) VOCAID: 37 cm x 25 cm x 4 cm (14 1/2" x 9 3/4" x 1 1/2"). Manufactured by Texas Instruments Inc., this portable device is for speech-impaired persons. It has a limited amount (24) of symbols or phrases which, when touched by finger or pointer, produce a synthesized voice. There are a limited number of overlays (4) available. It can be used with batteries or an adapter. There is no volume control. (Fig. A4)

Fig. A4 - VOCIAD

e) APOLLO AMPLIFIER: 48 cm x 38 cm x 33 cm (19" x 15" x 13"). Distributed by Commetrics Limited, this device is for the sight-impaired. There is a stand with a horizontally movable table. A camera and TV screen amplify any written or printed material up to 48 times. There is a choice of zoom, contrast focus, black on white or reverse, left-right and up-down motion. (Fig. A5)

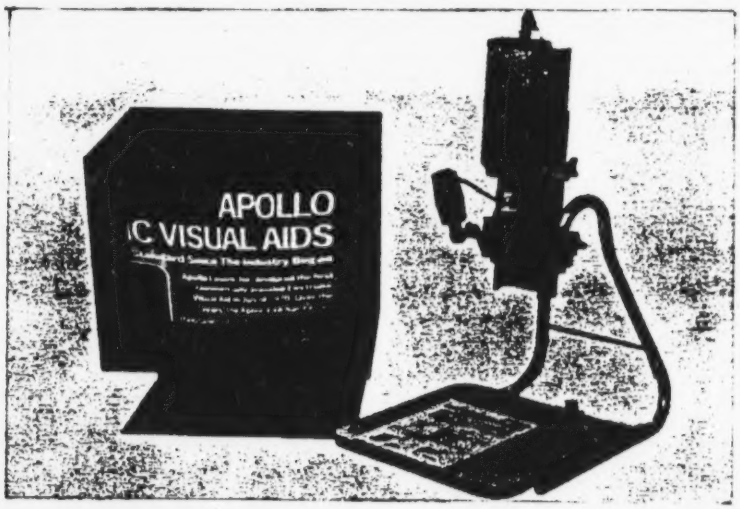


Fig. A5 - APOLLO AMPLIFIER

f) INFRARED AUDIO AMPLIFICATION SYSTEM: Made by Sennheiser, Germany, distributed by Solar Plus Ltée for hearing-impaired people. The system consists of transmitters and portable receivers. The receivers have either an earphone or an induction loop output for the use of the wearer. The transmitters are mounted in the building and radiate infrared signals, which reflect off most surfaces, but do not pass through walls like radio waves. (Fig. A6)

Fig. A6 - INFRARED AUDIO AMPLIFICATION SYSTEM

g) ACOUSTICAL FINDER: Prototype made by Commetrics Limited for the blind. This system is also based on infrared waves that radiate from a transmitter and produce infrared wave beams which can be picked up by a portable receiver. The sight-impaired person points a small box -7.5 cm x 5 cm x 4 cm (3" x 2" x 1 1/2")- in different directions until it meets the infrared beam of a transmitter. The receiver tells him/her, over a built-in speaker, an earphone or a hearing aid: "staircase", "exit", etc. The system is under development and is expected to function within the next months. (Fig. A7, A7a)

Fig. A7 - ACOUSTICAL FINDER

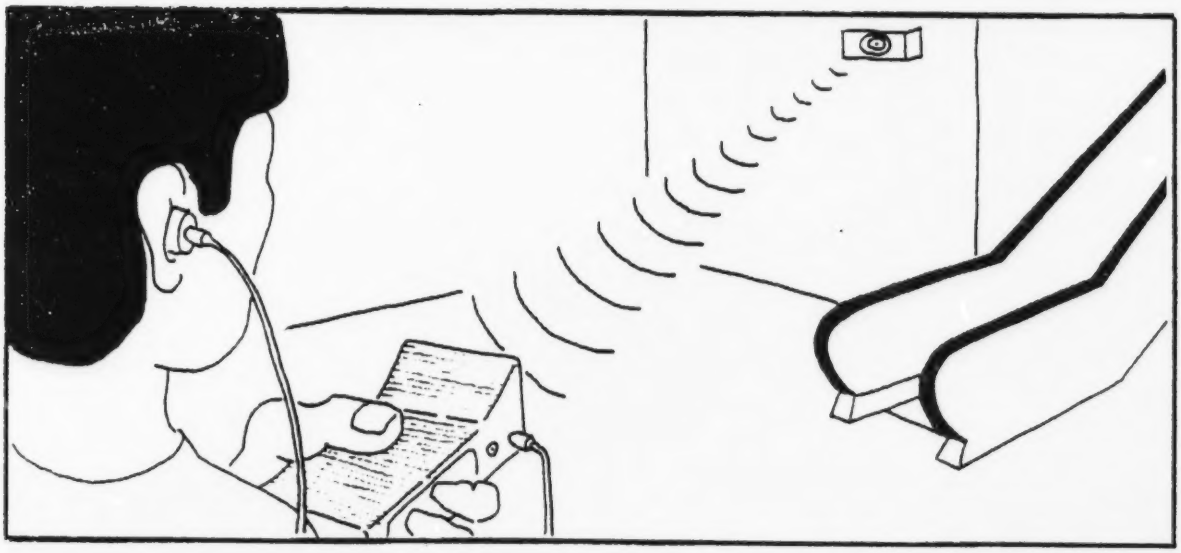


Fig. A7a - ACCUSTICAL FINDER

For the Form-a-Phrase, a travel-related overlay was designed by filling in typical questions, such as "where?", "how?", "I would like to". This new overlay was not used with a voice output, since it would have to be programmed. The keywords were colour-coded to allow faster recognition. (Fig. A8)

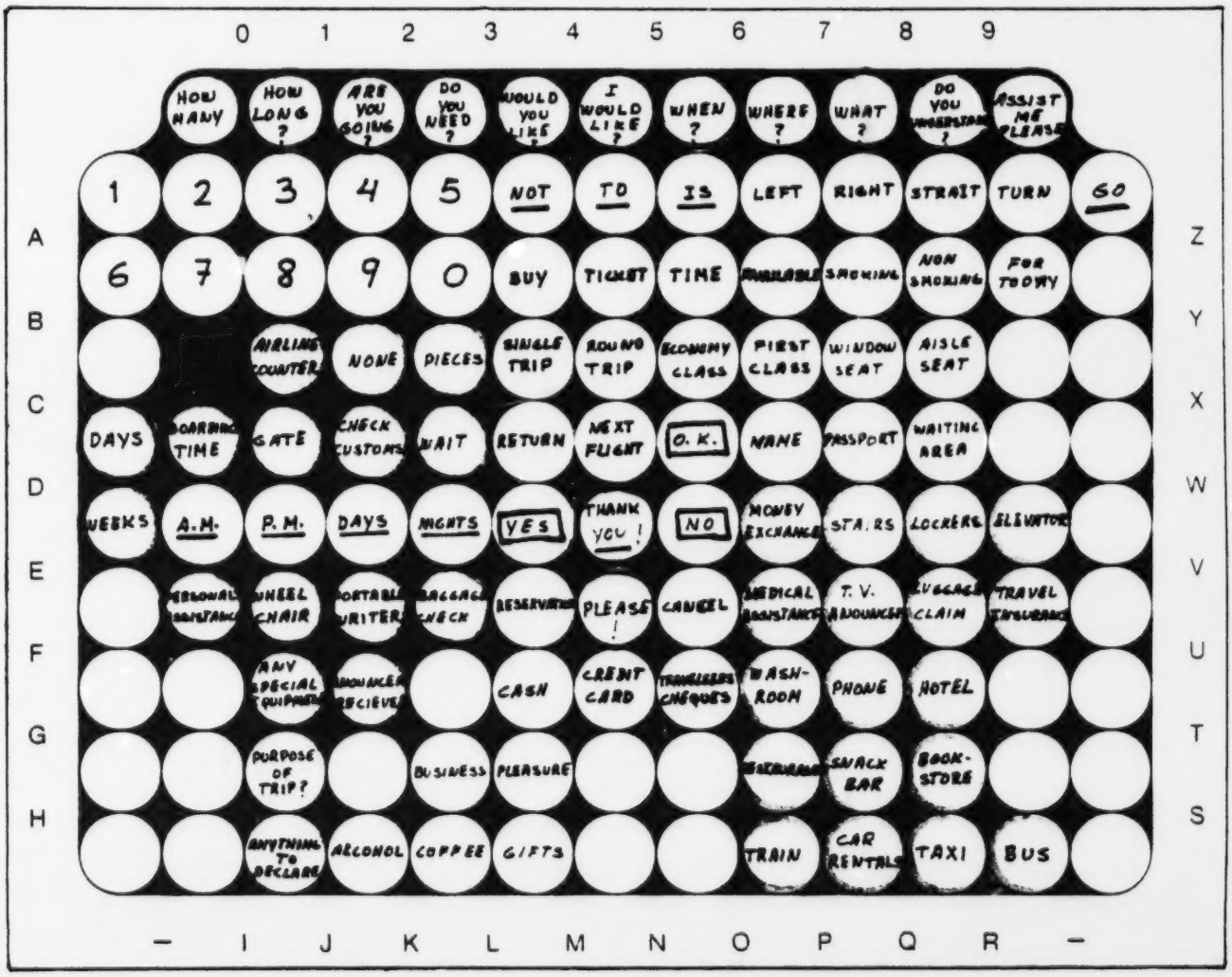
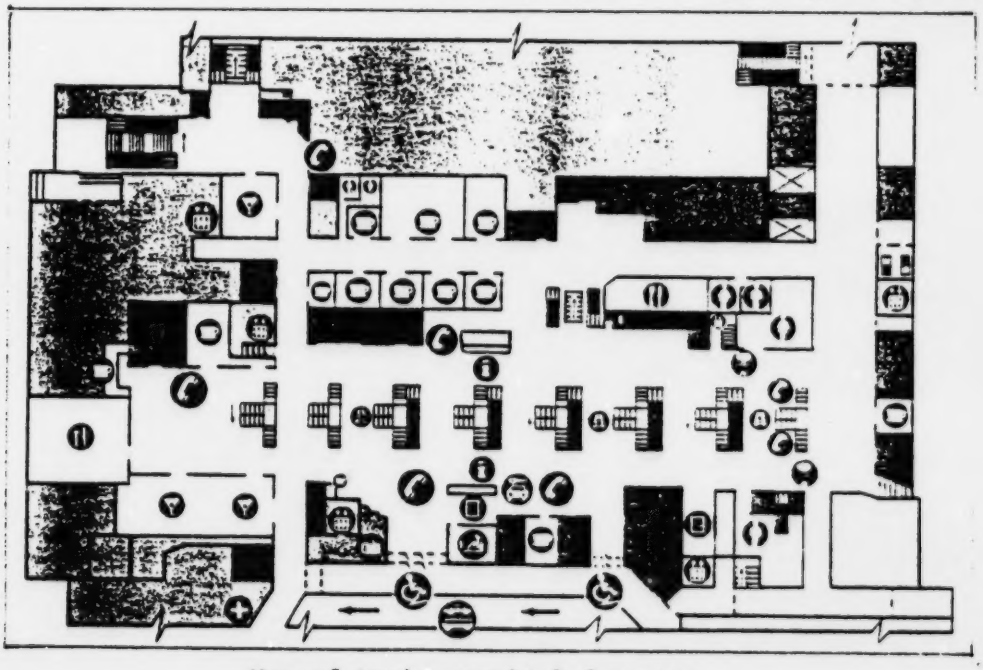

0 1 2 3 4 5 6 7 8 9
A B C D E F G H
Z Y X W V U T S
– I J K L M N O P Q R –
HOW MANY
HOW LONG ?
ARE YOU GOING ?
DO YOU NEED ?
WOULD YOU LIKE ?
I WOULD LIKE ?
WHEN ?
WHERE ?
WHAT ?
DO YOU UNDERSTAND ?
ASSIST ME PLEASE
1 2 3 4 5 NOT TO IS LEFT RIGHT STRAIT TURN GO
6 7 8 9 0 BUY TICKET TIME AVAILABLE SMOKING NON SMOKING FOR TODAY
AIRLINE COUNTER NONE PIECES SINGLE TRIP ROUND TRIP ECONOMY CLASS FIRST CLASS WINDOW SEAT AISLE SEAT
DAYS BOARDING TIME GATE CHECK CUSTOMS WAIT RETURN NEXT FLIGHT O.K. NAME PASSPORT WAITING AREA
WEEKS A.M. P.M. DAYS NIGHTS YES THANK YOU ! NO MONEY EXCHANGE STAIRS LOCKERS ELEVATOR
PERSONAL ASSISTANCE WHEEL CHAIR PORTABLE TYPEWRITER BAGGAGE CHECK RESERVATION PLEASE ! CANCEL MEDICAL ASSISTANCE T.V. ANNOUNCER LUGGAGE CLAIM TRAVEL INSURANCE
ANY SPECIAL EQUIPMENT ANNOUNCEMENT RECEIVED CASH CREDIT CARD TRAVELLERS CHEQUES WASH-ROOM PHONE HOTEL
PURPOSE OF TRIP? BUSINESS PLEASURE EXCHANGE SNACK BAR BOOK-STORE
ANYTHING TO DECLARE ALCOHOL COFFEE GIFTS TRAIN CAR RENTALS TAXI BUS

Fig. A8 - Reduced copy of overlay for Form-a-Phrase

After completing product testing, other types of tests were also done with the sight-impaired volunteers for general visual information such as signs and colours. The Transportation Development Centre Travel Guide* was used and found to be suitable only for people who can read maps. (Fig. A9)
A staff member posed as a wheelchair traveller to test the Visual Ear on public phones with respect to such features as operating height, light conditions, receiver arm reach and a place to write. One hearing-impaired traveller brought her own amplifier for use on public phones.



Map of train terminal from the
"Travel Guide" published by Transportation Development Centre*
Fig. A9

The Infrared System had to be simulated, since the installation of transmitters in an airport and the hook-up to the PA system would not have been possible within the short time span available and the technical involvement needed.

The test set-up used in the train station was essentially the same as that used in Dorval Airport, again simulating a "Communication Center".

Some procedural differences involve redcaps for assistance so more portable equipment might be necessary, but generally speaking similar questions and answers are used. For the technical aids it would mean only the replacement of certain keywords (e.g. train for plane, tracks for gates, etc.).

* TP 380

APPENDIX B - BASIC DIALOGUE FOR PURCHASE OF TICKET

Passenger: I would like/ to buy/ ticket.
Agent: Where to?
Passenger: Toronto. (Name of place is written on paper)
Agent: Single,/ round trip?
Passenger: Round trip/ please.
Agent: When?
Passenger: Today (otherwise written on paper)
Agent: Economy/ first class?
Passenger: Economy/ please.
Agent: Departure?
Passenger: 10 a.m.
Agent: Not available/ next flight 2 p.m.
Passenger: O.K.
Agent: When return?
Passenger: 2 weeks (date written on paper)
Agent: What time?
Passenger: 8 p.m.
Agent: O.K.
Agent: Name please?
Passenger: (Traveller hands out information in writing)
Agent: Smoking/ non-smoking?
Passenger: Non-smoking please.
Agent: Window/ aisle seat?
Passenger: I would like/ window seat.
Agent: Cash/ credit card?
Passenger: Credit card/ please.
Agent: O.K.
Passenger: Thank you.

Note: Text between slashes (/) indicates <u>one</u> field used on display board.

APPENDIX C - BASIC DIALOGUE FOR FLIGHT-RELATED PROCEDURES

Agent: Your passport please. (In case of international flight)
(Traveller hands it over)
Agent: Would you like/ smoking,/ non-smoking?
Passenger: I would like/ smoking/ please.
Agent: Would you like/ window seat,/ aisle seat?/
Passenger: I would like/ aisle seat/ please.
Agent: How many/ luggage?/
Passenger: 2 pieces.
Agent: Special equipment?
Passenger: None.
Agent: Boarding time 9:45/ gate 31/
Agent: Do you need/ personal assistance?/
Passenger: Yes.
Passenger: Where is/ gate/ 31?/
Agent: Ahead/ then left.
Agent: Would you like/ Portable receiver?/
Passenger: No/ thank you.
Agent: Would you like/ Portable writer?
Passenger: Yes/ please.

<u>In case of U.S.A. flight</u>

Agent: Where are you going?
Passenger: To New York (information written on paper).
Agent: Please/ check/ customs.
Agent: How long?
Passenger: 2 weeks.
Agent: Purpose of trip?/ Pleasure/ Business
Passenger: Pleasure.
Agent: Anything to declare?
Passenger: No (if yes, shows object or receipt).

If domestic flight the conversation finishes:

Agent: O.K.?
Passenger: Thank you.

Note: Text between slashes (/) indicates <u>one</u> field used on display board.